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Some opportunities for improving farm income in SOUTHEASTERN OHIO

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CONTENTS

SOME OPPORTUNITIES FOR IMPROVING FARM INCOME IN SOUTHEASTERN OHIO

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SUMMARY

Many farmers in southeastern Ohio can increase their incomes in two ways: (1) by obtaining a full-time job in industry; and (2) by expanding efficient livestock production. This conclusion is based on linear programming solutions which determined the optimum way of using given amounts of land, labor and capital.

How nearly an individual farmer can achieve the optimum farm situation will depend on local opportunities for work in industry, the farmer's age, and the amount of capital he can obtain for expansion of livestock production.

Consideration was given only to those alternatives that seemed most likely to yield the highest net income. Specifically, they included the following possibilities: a full-time job in industry along with farming, expansion of the various livestock enterprises, conversion of some permanent pasture to cropland, improvement of permanent pasture, and buying or selling corn and/or hay.

Optimum farm organizations were determined for four farms of different sizes and for four different amounts of additional capital. Sizes of typical farms used were 60, 120, 180 and 220 acres. Additional amounts of capital considered were $1,000, $3,000, $8,000 and enough to use completely all other available factors of production.

A study of 120 typical farms in 8 counties in southeastern Ohio provided information on land use patterns, crop yields, production systems and available labor. Prices used were those expected to prevail on the average for the 10 years from 1957 to 1966.

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A full-time off-farm job, along with as much farming as can be carried on with the time remaining, was found by linear programming to be the most profitable way of using the farm operator's labor.

A dairy herd producing milk for sale on a grade A milk market was the most profitable livestock enterprise. However, this class of livestock was not considered a practical alternative unless a herd of 7 or more cows could be kept. Unless more than $3,000 of additional capital was available, hogs and poultry were the more profitable livestock enterprises.

Beef cattle, sheep and dairy cows producing grade B milk were also considered as possible livestock alternatives. However, they were not profitable enough to come into the optimum livestock programs.

With a full-time job off the farm, the highest net income was obtained from the typical 120-acre farm. However, differences in income for the 120-, 180- and 220-acre farms were small when adequate capital was available.

Higher incomes under the optimum use of resources would come chiefly from raising more and better livestock than was done under the 1952 program. To make this change would require the application of more capital and labor.

Computations show that net income could be increased about $2,000 for farms of all sizes if about $12,000 additional capital were available to convert some of the permanent pasture to cropland, improve the permanent pasture and maintain a good-quality dairy herd producing grade A milk for sale.

INTRODUCTION

In southeastern Ohio, soils are relatively unproductive, farm labor frequently is not fully employed, and farm incomes are low. Soils and topography limit farmers' opportunities to increase earnings. But with better management of land, labor and capital, many could achieve higher incomes.

The purpose of this bulletin is to consider how farmers in the area can change their farm organizations to increase income. First, the farm resources that can be adjusted are identified. Farms of various sizes are described in terms of resources used, farming practices followed, products produced and net incomes obtained. Obstacles to increasing incomes on many farms are discussed. Then some of the alternative types of adjustments that are open to farmers are compared, and the best organization for each of four sizes of farms under various circumstances is indicated.

DESCRIPTION OF THE AREA

This study pertains specifically to Athens, Jackson, Meigs, Vinton, Lawrence, Hocking and Gallia Counties which are in the unglaciated Appalachian foothills. Creek valleys are typically narrow and hills are generally steep and rough. Soils are largely Muskingum silt loam with some Meigs silty clay loam. Both originated from sandstone and shale. Moderate to severe sheet erosion and considerable gullying has occurred on much of the area.

TABLE 1.—Changes in Selected Characteristics of Seven Southeastern Ohio Counties, Census Years, 1900, 1930 and 1950*

Item	Unit	1900	1930	1950
Total population	No.	208,778	191,461	201,137
Rural	No.	159,355	127,868	131,061
Rural farm	No.	†	63,326	58,026
Total farms	No.	18,963	13,458	12,319
Land in farms	Acre	1,752,507	1,460,850	1,274,800
Cropland harvested	Do	351,661	311,603	241,860
Corn harvested	Do	166,061	98,069	75,521
Livestock on farms:				
Cattle	No.	70,877	74,104	98,875
Sheep	No.	139,472	82,414	28,212
Hogs	No.	30,738	23,320	56,060
Horses and mules	No.	29,366	24,302	15,395

*U. S. Censuses of Agriculture, 1900, 1930 and 1950.
†Not available.

Non-Agricultural Industries.—Industries associated with non-agricultural resources provide employment for a large percentage of the rural population of the area. Thus they are important from the standpoint of the kinds of adjustments farmers may make to obtain higher incomes.

According to the Census of Agriculture for 1950, 52 percent of the farm operators in the 7 counties worked off the farm part of the time. About 37 percent worked more than 100 days away from the farm. On about half of the farms, off-farm work provided more income than agricultural production.

TABLE 2.—Occupation of Males 14 Years Old and Over, by Specified Counties, Southeastern Ohio, 1950

Occupation	Athens	Gallia	Hocking	Jackson	Lawrence	Meigs	Vinton	Total
	No.	No.	No.	No.	No.	No.	No.	No.
Males 14 years and over	17,734	9,092	7,123	9,847	17,330	8,345	3,768	73,239
Employed in:								
Agriculture	1,596	2,394	892	1,297	1,805	1,781	722	10,487
Mining	1,542	378	527	508	570	835	264	4,624
Construction	754	336	398	418	719	453	187	3,265
Manufacturing	1,146	321	1,453	1,830	3,833	478	583	9,644
Trucks, railroad, and other transportation	451	274	273	657	1,466	650	210	3,971
Utilities	453	108	118	92	141	340	32	1,284
Other occupations	3,541	1,706	1,301	1,823	3,206	1,364	542	13,483

An indication of the employment opportunities in the area is shown by the gainful occupations of males 14 years of age or older. Data in Table 2 were taken from the U. S. Census of Population for 1950. However, these figures do not reflect the fact that some individuals worked in more than one industry during the year.

Coal is mined commercially throughout the area. In recent years, commercial production has been at a low level because costs were higher than in competing coal fields. Iron was an important resource in parts of this area in the last century and furnaces were common in several of the counties. Timber was cut rapidly from the hills to provide the huge quantities of wood needed to produce charcoal for these iron furnaces. Much of the land around the furnaces is now owned by State and National Governments for forestry purposes.

Little virgin timber remains and forest products have ceased to be an important source of income. Few people are now employed in forestry, lumber and woodworking industries. Second-growth timber is usually harvested for rough lumber, pulpwood, or mine props. More valuable wood crops can be produced, however, under a system of sustained yields.

Clays and sandstone for a variety of building materials, glass, and other ceramic industries are abundant. Limestone deposits are found at several places in the area.

Gas and oil wells of low capacity are occasionally found throughout the area. Royalties and rents from gas and oil rights also provide some income for a few farmers.

METHODS OF STUDY

Background information for this study was obtained by interviewing 120 farmers in the area. The intent was to survey 30 representative farms in each of 4 common sizes as determined by the combined acreage of cropland and permanent pasture: (1) small farms, 20-49 acres; (2) medium small farms, 50-89 acres; (3) medium large farms, 90-139 acres; and (4) large farms, 140-220 acres. The proportion of farmland in timber and waste varies considerably from farm to farm.

Ten townships were selected at random in the 7 counties, except in the eastern portions of Meigs and Gallia Counties, which have somewhat different soils. All owner-operated farms in the selected townships were listed by size groups, and acreages of cropland and permanent pasture in 1950 were recorded. Three farms were randomly selected from each of the 4 size groups in each of the 10 townships.

Operators of the selected farms were interviewed in May and June of 1953. The following information was obtained for each farm: (1) present land use, (2) kinds and numbers of livestock kept, (3) cropping and livestock practices followed, (4) rates of production for crops and livestock, (5) kinds and amount of power and machinery, (6) characteristics of the labor available and amount used, (7) amount and kind of work done off the farm by the operator, and (8) opportunities and limitations for expansion of the farm business as viewed by the operator.

Only 94 complete and usable schedules were obtained for use in the analysis. They were distributed unequally among the 4 size groups. Several farmers in the sample were no longer engaged in farming; they were renting out all or most of their land or letting it lie idle. Others had changed the size of their farms between 1950 and 1953, which made it necessary to place the farm in a size class other than the one intended at the time it was selected for the sample.

Information obtained was used in several ways. First, it was summarized to show the kinds and amounts of various resources used on farms of different sizes, the opportunities for reorganization of farms as viewed by the operators, and some of the obstacles that stand in the way of more efficient use of resources. Second, all inputs used on farms were grouped into several broad classes and the regression of gross farm income on these groups of resources was estimated as a measure of their productivities.[2] This regression analysis provided estimates of the effect of variations in the amount of broad groups of resources on income at certain levels of use of other resources. This was helpful in diagnosing the direction in which profitable adjustments might be made. But it did not show the adjustments a farmer should make within a group of resources. Livestock investments as a category of inputs, for example, may include investments in dairy cows, hogs, sheep, or chickens. Even on a specialized dairy farm, livestock may include cows of different productivity. Adjustments in the proportion of various kinds or qualities of livestock may influence income as greatly as changes in the amount invested in livestock relative to other inputs.

Data from the survey also furnished a basis for selection of "typical" farm situations for which alternative adjustments could be appraised. Farms in each size group differed considerably, especially in amount of labor and equipment used and kind and amount of livestock produced. Under these conditions, average inputs and outputs do not closely represent the system of farming found on any one farm in the group. A typical farm situation makes a better base from which to measure the effects of changes in organization as it represents a "most likely" organization.

Linear programming was used to determine the particular adjustments that would be most profitable for each of the typical situations selected. The various alternative adjustments open to the operator of each typical farm were described and the combinations of the alternatives that would add most to net income, under various assumptions as to limitations in the use of resources, were determined.

CHARACTERISTICS OF SAMPLE FARMS

Methods of production and opportunities for reorganization differ for farms of various sizes. Important features of the farms and operators of each size class are given in Table 3.

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[2]The Cobb-Douglas type function was used in making the estimates.

A large proportion of the farmers on the small tracts did considerable work away from their farms. Average income from off-farm work was substantially higher for operators of small farms than for those of the larger farms. Many other features appeared to be associated with the extent to which operators worked away from their farms. Most

TABLE 3.—Land Use and Numbers of Livestock on Farms, by Size, and Class of Farm, Southeastern Ohio, 1952*

Item	Unit	Small		Medium-small		Medium-large		Large		All sizes	
		Full-time	Part-time	Full-time	Part-time	Full-time	Part-time	Full-time	Part-time	Full-time	Part-time
Total farms	No.	8	16	19	12	15	7	15	2	57	37
Size of farm	Acre	75.2	64.0	121.4	115.0	201.5	133.0	222.7	203.5	162.6	101.0
Total cropland	Acre	18.1	15.1	32.2	38.1	53.2	27.2	70.8	133.0	46.3	31.0
Corn	Acre	4.4	3.8	7.8	8.4	14.1	8.4	18.3	19.5	11.7	7.0
Small grain	Acre	5.5	2.0	3.6	7.9	9.5	3.4	13.3	22.5	8.0	5.3
Hay and pasture	Acre	5.2	3.9	14.6	14.1	25.7	12.7	28.3	22.5	20.0	9.9
Other crops	Acre	.7	.8	.2	0	.7	1.5	1.4	0	1.0	1.5
Idle	Acre	2.3	4.6	5.9	7.7	3.2	1.2	9.5	48.5	5.6	7.3
Permanent pasture	Acre	20.0	21.0	43.0	31.5	60.0	78.4	94.0	47.0	57.3	36.7
Woods and other	Acre	37.1	27.9	46.2	45.4	88.3	27.4	57.9	43.5	59.0	33.3
Livestock, Dec. 31:											
Beef cows	No.	1.6	0	2.6	2.0	7.5	.4	5.5	3.0	4.5	.9
Milk cows	No.	2.4	.7	3.4	3.1	4.2	4.3	8.7	4.0	4.9	2.3
Other cattle 1 yr. and over	No.	.8	.2	3.1	2.2	8.0	2.0	9.2	2.5	5.6	1.1
Calves	No.	2.1	.5	4.2	3.2	8.3	1.6	10.3	1.5	5.9	1.6
Ewes	No.	0	0	2.7	0	13.3	4.3	13.0	0	7.8	.8
Feeder lambs	No.	0	0	1.2	0	2.1	0	7.9	0	3.0	0
Sows	No.	.1	.4	.3	1.0	2.3	2.0	1.5	3.5	1.1	1.1
Laying hens	No.	30.0	15.0	30.0	30.0	94.1	11.4	138.5	112.5	75.5	24.5
Other poultry	No.	0	23.0	1.5	16.7	40.0	85.7	0	22.5	29.5	33.0
Horses	No.	.5	.2	.8	.8	1.8	0	.9	1.0	1.1	.6

*See page 7 for size of farm categories.

farmers who worked more than 100 days off the farm held full-time jobs which required 40 or more hours of time each week. They are referred to in this report as part-time farmers. Those who worked less than 100 days away from the farm are considered full-time farmers, even though farming operations did not always use all of the operator's available time.

TABLE 4.—Age of Operators, by Specified Sizes and Classes of Farms, Southeastern Ohio, 1952

Age of Operator	Size and Class of Farm*							
	Small		Medium-small		Medium-large		Large	
	Full-time	Part-time	Full-time	Part-time	Full-time	Part-time	Full-time	Part-time
	No.	No.	No.	No.	No.	No.	No.	No.
Under 40 years	--	7	3	3	2	2	2	--
40–54 years	1	7	2	6	5	4	4	2
55–64 years	4	2	5	2	5	1	5	--
65 years and over	3	--	9	1	3	--	4	--
Average in years	63	42	59	48	54	44	55	48

*See Table 3 for number of farms in each group.

Age of Farm Operator.—The extent to which farmers worked at off-farm jobs was closely related to the operator's age (Table 4). On the small farms, only 12 percent of the full-time operators were under 55 years of age; whereas 87 percent of the part-time farmers were under 55. About 21 percent of the full-time operators of the medium-small farms were under 55 years of age. Full-time operators of the two larger farm size classes were more equally distributed among the age groups, but only one of the part-time farmers in these size groups was over 54 years of age. No attempt was made to learn why older farmers did not work off the farm. Apparently, nonfarm opportunities were more limited for men over 55 years of age.

Part-time Farming and Farming Intensity.—Farmers who worked away from home 100 days or more farmed less intensively than those who farmed full-time. The part-time farmer used fewer days of labor, handled fewer head of livestock and had a smaller volume of business.

Table 5 shows that on medium-large and large farms, the total number of days of labor used on the farm, gross farm income and number of units of livestock handled averaged higher for full-time than for part-time farmers. This relationship was the same on the small farms. But

TABLE 5.—Comparison of Full- and Part-Time Farms by Size of Farm, Southeastern Ohio, 1952

Item	Size and Class of Farm*							
	Small		Medium-small		Medium-large		Large	
	Full-time	Part-time	Full-time	Part-time	Full-time	Part-time	Full-time	Part-time
	No.	No.	No.	No.	No.	No.	No.	No.
Total farms	8	16	19	12	15	7	15	2
Days of operator labor off-farm	10	252	15	230	11	236	6	100
Days of operator labor on-farm	91	62	179	120	323	79	298	234
Days unpaid family labor on farm	46	39	22	148	77	63	64	153
Days hired labor	.2	2 2	1 4	2 8	17 9	3.6	61.7	----
	Dol.	Dol.	Dol.	Dol.	Dol.	Dol.	Dol.	Dol.
Investment in power and machinery	684	366	1,265	1.867	2,627	1,714	2,995	2,638
Value of custom work hired	38	22	113	89	118	14	127	112
Gross farm Income†	1,607	976	2,953	2,706	5,621	2,148	8,368	4,260
Farm expenses‡	940	549	1,358	1,447	2,933	1,444	3,543	3,765
Net farm returns to labor and management	667	427	1,595	1,259	2,688	704	4,825	495
Income from off-farm work	100	3,315	178	3,491	140	3,971	67	2,450
Income from other sources§	371	94	151	0	209	0	0	0

*See page 7 for definition of size of farm.

†Including rental value of house and farm products consumed

‡Cash expenses plus depreciation and interest on investment

§Rents, royalties, pensions, etc

gross farm income, days of labor used on the farm and number of livestock did not differ between full-time and part-time farmers on the medium-small farms.

On the small full-time farms, labor inputs were low—202 days per year on the medium-small and only 137 days per year on the small farms. This low labor input may be explained by the fact that the full-time farmers on the small farms were older men; their ages averaged 60 years. Many of these farmers were semiretired and some were physically unable to handle much farm work.

Opportunities for Expansion of Farm Business.—Farmers were asked whether they had opportunities to increase their earnings by expanding farming operations, either by adding more land or by making fuller use of present acreage through such changes as adding more livestock, heavier fertilization of crops and harvesting of woodlots. Their responses are summarized in Table 6. Nearly half (46 percent) of the farmers knew of additional cropland that could be rented. Only 12 percent knew of any improved pasture in the community that was available for renting. Nineteen percent said they could rent some additional untreated permanent pasture.

The number and condition of buildings on farms limit the opportunities of some farmers to expand their livestock programs, but 52 percent of the farmers in the sample said they could handle additional

TABLE 6.—Farmers' Opinions Regarding Opportunities for Expanding Farm Business, Southeastern Ohio, 1952

Question	Farmers who replied "Yes"	Percentage of total who replied "Yes"
	Number	Percent
Could you rent additional cropland?	43	46
Could you rent additional improved pasture?	11	12
Could you rent untreated permanent pasture?	18	19
Could you handle more livestock with present buildings?	49	52
Would it pay to have more livestock?	23	24
Could woodlot be harvested for additional income?	37	39
Would it pay to use more fertilizer than you are now using?	53	56
Would you have difficulty borrowing money for any of the above?	2	2

livestock with their present buildings. Twenty-four percent thought it would pay to increase production of livestock on their farms. More than half (56 percent) of the farmers thought it would pay to use more fertilizer than they used in 1952.

Many of the farmers who thought it would pay to add livestock or apply more fertilizer were short of capital to finance the additions. However, most of them indicated that they were restrained from borrowing for profitable expansion of their businesses by their own unwillingness to borrow rather than by the unwillingness of credit agencies to lend them money. Only 2 farmers thought they could not borrow enough money to finance the added expenditures that they believed would pay.

ADJUSTMENTS TO INCREASE INCOME

To provide optimum net income, the use of farm resources needs to be adjusted from time to time as the relative productivities of the resources change or as prices and costs change. On an efficiently organized farm that provides optimum net income, each resource is allocated among its alternative farm uses in such a way that use of an additional unit in one alternative adds at least as much to net income as it would if applied to any other alternative use. That is, its marginal value productivity is the same in all uses (when marginal value productivity is defined as the amount added to total income by the last unit of a resource added). The marginal value productivity of a pound of fertilizer in production of corn, for example, is the value of the increase in yield of corn when the fertilizer applied to a given area is increased by one pound. The marginal value productivity of a resource in a particular use depends upon the total amount of the resource applied in relation to the amount, kind and quality of other resources combined with it, and the price of the product.

Farm resources are characteristically subject to diminishing marginal returns; that is, as more of a resource is used, other things being equal, its marginal value productivity ultimately decreases. That is, after a certain point in application is reached, the marginal value productivity of a resource is increased by reducing the amount of that resource used in relation to other resources. Thus, if the amount of labor used on a farm is reduced, the marginal value productivity of labor generally tends to increase. But, as this would increase the proportion of other resources relative to labor, the marginal value productivity of the other resources would then be reduced.

This suggests that if the marginal value productivity of a particular resource on a farm is less than it would be in some alternative use, the resources may be reorganized for greater efficiency and higher net income: (1) Part of the particular resource may be shifted to more profitable farm enterprises; (2) the amounts of other resources combined with it may be increased, or (3) part of this resource may be shifted to nonfarm employment. If a farm operator could expect income from an additional week of work on crops to be less than the returns from a similar amount of time spent on an off-farm job, for example, a rational adjustment for increased efficiency and income might involve either: (1) A shift of the labor to some livestock enterprise; (2) an increase in the amount of land in the farm unit; (3) an increase in the amount of productive capital, such as fertilizer or improved seeds used in crop production; (4) a shift of some labor from the farm to off-farm employment, or (5) some combination of these types of adjustments.

Resource Productivity.—Estimates of marginal value productivities of resources are helpful in arriving at production decisions that will increase income. Estimates were made of the marginal value productivity of resources used on the farms in the survey sample (Table 7).[3] Such estimates for each item used in farm production are desirable, but it is necessary to combine the inputs into a few groups to avoid difficulties in computation. In this study, resources on each farm were combined into the following groups: (1) Acres of cropland, (2) acres of permanent pasture, (3) days of available labor on the farm, (4) investment in livestock, (5) annual livestock expenses, (6) investment in power and machinery and (7) annual crop expenses. Output was measured in terms of gross farm income. Values of inputs and products were computed at 1952 prices. In calculating the mar-

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[3]Marginal value productivity estimates were derived from a Cobb-Douglas type production function computed by least square multiple regression. The production function obtained was the following:

$$Y = 6.786\, X_1^{.32868}\, X_2^{.11272}\, X_3^{.37066}\, X_4^{.43262}\, X_5^{.06814}\, X_6^{-.07570}\, X_7^{-.12398}$$

The elasticities summed to 1.11314 indicating slightly increasing returns to scale. All coefficients were significant at the 5 percent probability level except for inputs X_6 and X_7.

TABLE 7.—Estimates of Marginal Value Productivities of Resources for All Sample Farms, Southeastern Ohio, 1952*

Resource	Unit	Average input	Marginal value product
			Dollars
Cropland	Acre	42.5	27.54
Permanent pasture	Do	49.7	8.07
Labor	Day	287.3	4.59
Livestock investment	Dollar	2,999.22	.51
Livestock expense	Do	380.70	.64
Power and machinery	Do	1,753.22	—.15
Crop expenses	Do	693.01	—.64

*All other inputs have been held at their means.

ginal value productivities of each group of inputs, the amount of each other group of resources was held constant at the average for all farms in the sample.

The marginal value productivities are shown separately for full-time and part-time farmers for each of the four size-of-farm classes in Table 8.[4] The higher marginal value productivity of cropland on the full-time farms supports the hypothesis that full-time farmers work their land more intensively than part-time farmers. It indicates that a full-time farmer can outbid a part-time farmer in renting cropland. The negative values indicate that additional investment in power and machinery and increased annual expenditures for crop production on each size of farm, other things equal, would add nothing to farm income.

The marginal value productivity estimates in Tables 7 and 8 were useful in showing the general direction of the changes needed. But they have limitations because they are for groups of resources rather than for specific factors. Within each group of resources are items that differ markedly in marginal productivity. All power and machinery items, for example, are grouped into a single category. The marginal

[4]These estimates are derived from the production function computed from the entire sample of farms. The marginal productivity estimates for the small and large farms may be less accurate than estimates near the average for all farms because of the inflexibility of the Cobb-Douglas function.

TABLE 8.—Estimates of Marginal Value Productivities of Resources, by Size and Class of Farm, with All Other Resources Used at the Average Level for Each Group of Farms, Southeastern Ohio, 1952

Resource	Unit	Size and Class of Farm							
		Small		Medium-small		Medium-large		Large	
		Full-time	Part-time	Full-time	Part-time	Full-time	Part-time	Full-time	Part-time
		Dol.	Dol.	Dol.	Dol.	Dol.	Dol.	Dol.	Dol.
Cropland	Acre	27.93	14.59	25.83	21.84	34.41	24.22	29.56	15.18
Permanent pasture	Do	4.20	3.58	6.59	9.19	8.93	3.05	7.76	12.52
Labor	Day	2.02	2.40	4.61	3.46	4.92	5.19	5.66	5.00
Livestock inventory	Dollar	.25	.85	.47	.58	.51	.49	.45	.88
Livestock expenses	Do	.19	1.46	1.14	.99	.41	.48	1.02	.22
Power and machinery	Do	—.08	—.16	—.15	—.10	—.16	—.09	—.16	—.15
Crop expenses	Do	—.38	—.42	—.61	—.55	—.75	—.61	—.62	—.67

value productivity of power and machinery as a bundle of resources was essentially zero (the estimate was actually $–0.15). It might be profitable, however, to sell some of the equipment such as hay balers and invest the money in tractors or other equipment. An additional problem arises because of measurement difficulty of some of the inputs. Units of labor were measured in number of days of work per farm, which does not reflect the wide difference in the quality of labor. Operators' ages ranged from 19 to more than 80 years. Obviously, a day of labor by one operator differs from that of another. Similarly, livestock inputs were not measured adequately by investment in livestock because of variations in qualities and kinds of animals found on the different farms. While the marginal value productivities indicate that it would pay to invest more money in livestock, they do not indicate whether the additional investment should be in dairy cows, beef cattle, hogs, sheep, or poultry.

DATA USED TO DETERMINE OPTIMUM COMBINATION OF RESOURCES

The high marginal productivity of capital invested in livestock indicates that more capital could be used profitably, but the composite figure does not suggest the kinds of livestock that should be added. To answer such questions more satisfactorily, various alternatives open to farmers in the area were studied by the procedure known as **linear programming.**[5]

Land Use.—Present and proposed acreages in crops are shown in Table 9. Present acreages approximate the average land use pattern found on each of the 4 size groups in1952. On the small farms, about

[5]For a description of this procedure and its application, see Charnes, A., W. W. Cooper and A. Henderson, An Introduction to Linear Programming.

TABLE 9.—Present and Proposed Land Use, by Size of Farm, Southeastern Ohio

	Size of Farm			
	Small	Medium-small	Medium-large	Large
	Acres	Acres	Acres	Acres
Total land in farm	60	120	180	220
Present land use:				
Corn	4	7	11	14
Wheat	4	7	11	14
Meadow	4	14	22	28
Total cropland	12	28	44	56
Permanent pasture	20	40	60	66
Woods and miscellaneous	28	52	76	98
Proposed land use:				
Corn	5.5	10.7	16.2	19.7
Wheat	5.5	10.7	16.2	19.7
Meadow	11	21.6	32.6	39.6
Total cropland	22	43	65	79
Permanent pasture	10	25	39	43
Woods and miscellaneous	28	52	76	98

one-fifth of all land was in cultivated crops. But on the other 3 groups, about one-fourth of the land was rotated. In 1952, the prevailing rotation was corn, wheat, and 2 years of hay or pasture except on the 60-acre farms, where the crop sequence was corn, wheat, and one year of meadow. This shorter rotation was followed to compensate for a smaller proportion of cropland. Only a few areas were contour strip cropped.

Proposed acreages were determined from soil capability classes used locally to develop cropping patterns to control erosion and increase crop yields. These acreages were used in the linear programming process for more efficient crop production. Soil capability maps showed that about 36 percent of the total farm area could be used for cultivated crops. On this basis, cropland was increased 10 acres on the 60-acre farm, 15 acres on the 120-acre farm, 21 acres on the 180-acre farm, and 23 acres on the 220-acre farm. To get this increase in cropland, two requirements would have to be met. A rotation of corn, wheat and 2 years of hay or pasture would have to be followed. Also, contour strip cropping would be needed on all slopes subject to erosion.

Although nearly half of the farmers interviewed thought they could rent some additional cropland, this alternative was not considered because most tracts would be too small and not easily accessible.

Crop Yields.—The following yields were used in determining the optimum combination of resources: corn 60 bushels per acre, wheat 20 bushels and hay 2.0 tons per acre. These yields are approximately the same as those found in the sample. No increase in yields per rotation was assumed because present rates of fertilization conform closely to current recommendations.

Present and proposed fertilizer applications on corn were 370 pounds per acre of a 3-12-12 analysis. For wheat, 300 pounds were used. None was put on meadows. Hay yields were based on assumptions of one ton of agricultural ground limestone every 4 years for maintenance purposes. All land converted from permanent pasture to rotated crops would also receive an initial application of four tons of lime per acre.

Yields of permanent pasture are shown in Table 10. Yields for unimproved pasture are based on using no lime or fertilizer. Yields for improved pasture are based on an initial fertilizer application of 500 pounds per acre of 0-20-0 analysis. Subsequent applications would amount to 300 pounds per acre of the same analysis every 3 years. In addition, four tons of agricultural ground limestone would be used as an initial application followed by one ton every 4 years. Weeds and brush would be controlled by clipping at least once a year.

TABLE 10.—Estimated Yields per Acre for Unimproved and Improved Permanent Pasture, Southeastern Ohio*

Kind of pasture	Cow days of pasture produced in month of†							
	April	May	June	July	August	September	October	November
Unimproved	--	12	13	5	2	5	4	--
Improved	9	33	33	14	7	14	14	6

*Based on data in following publication: Dodd, D. R., Good Pasture, Ohio Extension Bulletin No. 345, August, 1954.

†A cow day of pasture represents 15 pounds of total digestible nutrients.

Labor Supply.—Available labor limits the opportunities for adjustment on many farms. Labor is often difficult to hire when needed, particularly in spring and fall when farm work loads are at their peaks. Some farmers hired schoolboys during the summer, but because many farmers had difficulty in hiring seasonal labor, the assumption was made that the labor supply furnished by the farm operator and his family set limits for the typical farmer. The assumed maximum labor supply for typical farms is shown in Table 11.

Capital Supply.—In computing the most profitable plan for each of the four typical farms, the value of feed and livestock already on the farm was considered to be "Available Capital". Existing machinery, land and buildings would remain the same in an adjusted organization as in a typical situation, so investment in these resources was ignored until the final computation of labor income at the conclusion of the linear programming procedure. This "Available Capital" in the 1952 opening inventory amounted to $250, $1,450, $1,475 and $1,950 for the 60-, 120-, 180- and 220-acre farms respectively. Where livestock of improved quality were introduced into the adjusted organization to replace the "typical" poorer animals, a sale and purchase up to the amount of inventory value of the original animals, was assumed.

Potential adjustment in farm organization was obviously limited by available capital. The most profitable farm plans were calculated on the basis of adding additional capital to available capital, in amounts of $1,000, $3,000 and $8,000. Calculations were made also for situations in which capital could not become limiting until the other factors of production were completely utilized. Thus, in effect, additional capital is added capital, which may be used for additional crop and livestock cash expenses, new investments in livestock and livestock

TABLE 11.—Assumed Maximum Labor Supply Available on Typical Family Farms, by Months, Southeastern Ohio

	Operator*	Operator's family	Total labor
	Hours	Hours	Hours
January	317	44	361
February	284	40	324
March	317	44	361
April	332	43	375
May	344	44	388
June	332	171	503
July	344	177	521
August	344	177	521
September	332	43	375
October	344	44	388
November	306	43	349
December	317	44	361

*Available operator's labor assumes 11 hours per week-day for farm operation, off-farm work and travel for the months of November through March, and 12 hours per week-day for April through October; only 4 Sundays per month, at 5 hours per day, were assumed for each month. This recognizes that as much as a 22 or 23-day off-farm work month might occur.

equipment, clearing or renovating land, purchase of fertilizer and lime, or any other productive farm process. The term "additional capital" is used in this sense throughout this bulletin.

Net Income.—One of the first steps in the linear programming process was to determine net income, monthly labor requirements, and the amount of capital needed for each activity considered. Net income for each unit of the various activities was needed to determine the profitability of combining different crop and livestock programs. Monthly labor requirements were needed to show when the demands for this factor were greatest in relation to the supply. Capital requirements for each activity had to be computed because expansion of the various activities depended upon the amount of additional capital assumed to be available. Net income, amount of labor needed in April, and capital requirements for each unit of activity are shown in Table 12.

TABLE 12.—Net Receipts, Amount of Labor and Capital Used, by Specified Activities in Linear Programming, Southeastern Ohio

Activity	Unit	Gross receipts	Costs*	Net income	April labor needed	Capital needed per unit†
					(hours)	
Dairy herd No. 1‡	Cow	$408.00	$131.00	$277.00	10.5	$666.00
Dairy herd No. 2§	Cow	305.00	114.00	191.00	10.5	484.00
Beef herd No. 1‖	Cow	85.00	29.00	56.14	3.0	241.00
Beef herd No. 2**	Cow	169.00	53.00	115.66	4.2	322.00
Hogs	Sow	553.00	165.00	388.33	7.1	323.00
Sheep	Ewe	24.00	6.00	18.05	1.5	32.00
Poultry	Hen	6.51	4.46	2.05	.3	6.38
Rotation cropland***	Acre	9.25	31.51	—22.26	.3	21.00
Converted cropland***	Acre	9.25	34.66	—25.41	.3	51.00
Improved pasture	Acre	0	7.02	—7.02	0	30.50
Corn purchased	Bu.	0	1.57	—1.57	0	1.50
Hay purchased	Ton	0	24.15	—24.15	0	23.00

*Excluding fixed land and building costs, but including cash expenses, interest on investment, and equipment depreciation.

†This includes investment value of the productive unit plus cash operating expenses. It also includes investment in livestock replacements and equipment. It excludes depreciation cost and interest charged on investment. See Table 15.

‡Milk sold as grade A.

§Milk sold as grade B.

‖Calves sold as feeders.

**Calves fattened to slaughter weights,averaging 900 pounds.

***Figures for 180-acre farm assuming that all potential cropland is farmed. Figures for farms of other sizes and for situation where no conversion of pasture to cropland is undertaken would be slightly different.

Net income for the various activities was determined by subtracting costs from gross receipts. Gross receipts for each unit of livestock were computed by multiplying physical production for sale in Table 13, by the prices listed in Table 17.

Gross receipts from present and converted cropland include only the sale of wheat. Wheat returns were figured on the basis of a yield of 20 bushels per acre at $1.85 per bushel on one-fourth of the rotated land. Crops marketed through livestock were not assigned a sale value because they were included in the gross receipts from the various livestock enterprises. As the cost of raising all crops was greater than the receipts from wheat, net income from cropland became a negative

number. Actually, corn and hay also could have been sold to yield a direct cash return rather than fed to some livestock enterprise. In either instance, the crop enterprises are credited with income. The method used in this study employs another activity whereby hogs and dairy cannot come into the solution until corn and hay are available for them through either production or purchase.

Net income from improved permanent pasture also was stated in negative terms becauses receipts from this crop were accounted for by the sale of livestock and its products. The purchase of a unit of corn and hay would reduce net income by an amount equal to the purchase price plus a 5 percent interest charge.

The quantities of livestock products for sale as listed in Table 13 were based on the following level of management. Dairy cows were assumed to produce 9,000 pounds of milk testing 4 percent, of which 8,500 pounds could be sold. The calf crop would average 90 percent. Twenty percent of the cows would be replaced annually. Cull cows would average 1,100 pounds in weight when sold. Death loss was figured at three percent. Calves would be sold at the age of one week unless needed for replacement purposes.

Two systems of beef production were considered. One included selling feeder calves the first fall at weights averaging 400 pounds. The other included feeding the calves over winter and selling as choice slaughter cattle. Heifers would average 850 pounds and steers 950 pounds. The calf crop would average 90 percent. Cows would be replaced at an average annual rate of 15 percent and would weigh 1,200 pounds when sold. Death loss was figured at 3 percent.

Gross income from hogs was based on a two litter system which would produce 14 pigs as market hogs or replacement gilts. Sows would be kept for four litters. Death losses of sows would amount to 7 percent. Market hogs would average 215 pounds and cull sows 500 pounds when sold.

Gross income from sheep was based on a 120 percent lamb crop and a replacement rate of 20 percent of the ewes each year. Death loss of ewes was figured at 10 percent. Fleeces of wool averaged 9 pounds per ewe.

Gross income from poultry was based on a flock producing an average of 170 eggs for sale per opening inventory hen. Death loss was figured at 25 percent for old hens and 5 percent for baby chicks. Cull hens would be sold at an average of 75 cents each.

Detailed costs for the various classes of livestock are shown in Table 13. Estimated annual crop costs for each acre of rotated land are itemized in Table 14. These costs include only the ones that would be incurred if more of any crop or productive livestock were raised.

TABLE 13.—Estimated Gross Receipts, Costs, and Net Income per Unit of Livestock, Southeastern Ohio

Item	Unit	Dairy cow*	Dairy cow†	Beef cow‡	Beef cow§	Sow (2 litters)	Ewe	Hen
Production for sale:								
Milk	lb.	8,500	8,500	----	----	----	----	----
Veal	lb.	90	90	----	----	----	----	----
Cull cow	lb.	213	213	167	167	----	----	----
Feeder calf	lb.	----	----	300	----	----	----	----
Fat cattle	lb.	----	----	----	660	----	----	----
Hogs	lb.	----	----	----	----	2,881	----	----
Cull sow	lb.	----	----	----	----	250	----	----
Lamb	lb.	----	----	----	----	----	88	----
Cull ewe	lb.	----	----	----	----	----	13	----
Wool	lb.	----	----	----	----	----	11	----
Cull hen	Dol.	----	----	----	----	----	----	.56
Eggs	Dol.	----	----	----	----	----	----	170
Gross receipts	Dol.	407.53	305.00	84.71	168.52	553.58	24.11	6 51
Costs per unit:								
Vet and medicine	Dol.	10.50	10.50	3.00	4.00	23.00	.76	.03
Bedding	Dol.	9.00	9.00	4.00	7.40	.00	.14	.09
Grain purchased	Dol.	16.00	16.00	.00	.00	.00	1.40	.69
Feed grinding	Dol.	3.68	3.68	.00	3.78	18.85	.05	.03
Protein supplement	Dol.	26.70	26.70	2.07	12.27	62.88	.51	2.53
Insurance and taxes	Dol.	8.10	6.42	3.15	4.31	4.12	.39	.05
Miscellaneous	Dol.	29.10	29.10	4.30	5.00	44.26	1.20	.82
Interest‖	Dol.	27.45	12.60	12.05	16.10	12.14	1.61	.22
Total	Dol.	130.53	114.00	28.57	52.86	165.25	6.06	4.46
Net income	Dol.	277.00	191.00	56.14	115.66	388.33	18.05	2.05

*Milk sold on grade A market.

†Milk sold on grade B market.

‡Calves are sold the first fall at 400 pounds as feeder calves.

§Calves are fed over winter and sold as choice cattle weighing 900 pounds in the second summer.

‖On investment in livestock and special equipment.

TABLE 14.—Estimated Annual Crop Costs per Acre of Corn-Wheat-Meadow-Meadow Rotation, Southeastern Ohio

Item	Cost
	Dollars
Seed	2.92
Fertilizer	4.18
Lime	1.25
Weed spray	.63
Fuel and oil	2.36
Machinery charge	12.25
Machine hire	6.50
Insurance on stored crops	.10
Taxes on corn and hay	.25
Interest	1.05
Electricity	.02
Total	31.51

*For 180-acre farm. Slightly different costs were used for farms of other sizes. These costs apply to existing cropland. Estimated annual costs for converted cropland is $34.66.

Land and building costs that would remain the same regardless of the amount of crops and livestock raised were not considered in determining the optimum combination of resources but were later included in the final labor income figure for each farm solution.

Converted cropland had higher costs than present rotated land because of additional expenditures for clearing and initial application of lime. In figuring the cost of production, these charges were amortized over a 10-year period. Costs of improving permanent pasture included the costs of lime and fertilizer and mowing charges.

In reorganizing a farm, seasonal demands for labor should be considered in relation to the supply. Otherwise, the farmers may not be able to do all the work required at certain times of the year. In the study reported, April was found to be the most critical month from the standpoint of labor needed on the farm. At this time of year, livestock still demanded large amounts of labor and some spring work on crops had to be done. Therefore, the amount of April labor needed for each activity had to be determined because labor demands during this period would set limits on the number of livestock that could be kept. When a farmer worked full time off the farm, the assumption was made that in April he would have only 176 hours of labor available for farm work.

TABLE 15.—Investments per Unit for Land Improvements and Livestock Adjustments, Southeastern Ohio

Item and Unit		Investment
		Dollars
Permanent pasture improvement:		
Lime, initial application, 4 tons	per acre	20
Fertilizer, 0-20-0, initial application, 500 lbs.	do	10
Total	do	30
Conversion of permanent pasture to cropland:		
Clearing (small trees and brush)	do	10
Lime, initial application, 4 tons	do	20
Total	do	30
Dairy herd (grade A milk):		
Livestock inventory	per cow	420
Special dairy equipment and milk house	do	238
Operating capital*	do	8
Total	do	666
Dairy herd (grade B milk):		
Livestock inventory	do	420
Equipment	do	57
Operating capital*	do	7
Total	do	484
Beef herd, feeder calves sold:		
Livestock inventory	do	222
Special equipment	do	3
Operating capital*	do	16
Total	do	241
Beef herd, calves fed out as choice cattle second year:		
Livestock inventory	do	285
Special equipment	do	5
Operating capital*	do	32
Total	do	322
Sheep, lambs fed out:		
Livestock inventory	per ewe	27
Special equipment	do	1
Operating capital*	do	4
Total	do	32
Hogs (2 litters system):		
Livestock inventory	per sow	96
Special equipment, portable houses	do	160
Operating capital*	do	67
Total	do	323
Poultry, laying flock:		
Livestock inventory	per 100 hens	150
Housing and equipment	do	400
Operating capital*	do	29
Baby chicks	do	59
Total	do	638

*This item is cash operating expense per unit for one turnover period. A turnover period is one month for dairy and poultry, six months for hogs, and one year for beef and sheep.

Capital requirements were computed for the additional investments needed to finance one unit of each activity (Tables 12 and 15). Investments that would remain the same regardless of the type of farming followed were omitted from these capital estimates. However, total capital requirements and fixed charges for the entire farm were taken into consideration in figuring labor income for the farm.

Feed Requirements.—For the various classes of livestock, feed requirements used were based on several studies conducted by the Agricultural Economics Department.[6] Specific requirements in Table 16 are based on the levels of production assumed in this study.

Prices Used.—Anticipated prices for the 1957-66 period were used in determining net receipts from the different farm enterprises. Several price sources were consulted. Prices of specific products are shown in Table 17.

Off-Farm Work.—In determining the most profitable way to use all available labor, off-farm work was considered as a possible alternative. When off-farm employment was considered in the calculations,

[6]Sitterley, J. H. "Rates of Feed Consumption by Livestock". Department of Agricultural Economics and Rural Sociology, Ohio State University, Extension Bulletin No. 308, Revised 1955. Other unpublished studies were used also.

TABLE 16.—Feed Requirements Used per Unit of Livestock, Southeastern Ohio*

Kind of livestock	Corn	Oats	Hay	Protein supplement	Pasture in terms of hay equivalent July-Sept.†
	Bushels	Bushels	Tons	Lbs.	Tons
Dairy cow	35	20	4.2	600	2.4
Beef cow and feeder calf	4	0	2.5	30	2.4
Beef cow and slaughter animal	40	0	3.0	90	2.4
Sow and 14 market hogs	225	0	.07	1295	.12
Ewe and market lamb	2.2	1	.3	3	.42
100 hens	53	28	0	6050‡	.5

*Includes replacements.

†May and June pasture was assumed to be non-critical and is not included in these requirements.

‡Mash.

TABLE 17.—Estimated Long Range Prices for Farm Products in Ohio, 1957-66

	Unit	Price per Unit
Corn	Bu.	$ 1.35
Wheat	Bu.	1.85
Hay	Ton	18.00
Milk grade A (net)	Cwt.	4.40
Milk grade B (net)	Cwt.	3.40
Sows	Cwt.	14.00
Market hogs	Cwt.	18.00
Cull cows, dairy	Cwt.	12.00
Cull cows, beef	Cwt.	13.00
Beef for slaughter	Cwt.	*22.20
Beef feeder calves	Cwt.	21.00
Dairy veal calves	Each	12.00
Lambs	Cwt.	20.40
Wool	Lb.	.51
Eggs	Doz.	.42

*Price of fat steers and heifers weighed in proportion to pounds of each marketed.

the assumption was made that the farmer would work a 40-hour week. An additional one hour per day of travel to and from work is also required. This assumption was made because most off-farm jobs in southeastern Ohio are in industry which requires regular working hours at the employer's convenience. Only in exceptional instances can farmers work part-time in industry, or at jobs where the hours of work can be adjusted to meet the needs of the worker.

THE MOST PROFITABLE COMBINATION OF ENTERPRISES FOR TYPICAL FARMS

Many different combinations had to be studied by linear programming in order to select the best combination of enterprises. Solutions were being sought for four different sizes of farms and for four different levels of available capital for each size of farm. In addition, four possibilities of land use were considered for each size and capital situation. These included: (1) following the present land use pattern; (2) improving the permanent pasture land; (3) converting some of the

permanent pasture land to cropland; and (4) both improving some pasture and converting some pasture land to cropland. An additional possibility tested was whether it was more profitable to work part-time off the farm and devote the remaining time to farming or to farm full time. One other change in the available markets was introduced also. In one situation tested only a market for manufactured milk was available. The other assumed a grade A fluid milk market as an outlet.

For each of these 256[7] different situations, all possible combinations of several livestock enterprises were tested, including dairy, beef, hogs, sheep and poultry. For a dairy herd producing grade A milk, it was assumed that at least seven cows would be the minimum acceptable size of herd. Opportunities to buy or sell corn or hay were included also.

Preliminary analysis of selected key programs was used to reduce the number of problems to be solved. It was found that when additional capital was $3,000 or lower, the possibility of dairy herd producing grade A milk was eliminated. It was found that in each instance hogs and poultry were better choices than dairy herds producing manufacturing milk. Sheep flocks and beef herds were not found to be optimizing in any of the problems.

Improvement of permanent pasture was found to be profitable only when dairy herds were indicated. However, in two situations in which only $8,000 of additional capital was available on the 180- and 220-acre typical farms, other uses of this capital were more profitable than its use for improving pastureland.

In all instances, it was profitable to convert much of the gentler sloping permanent pasture to cropland in order to produce more feed, rather than to buy feed.

For all sizes of farms and for each capital situation, a farmer realized more total net income if he held a full-time job off the farm, working a 40-hour week and spending the remaining available time doing as much farm work as possible, than if he spent his full time operating the farm.

Livestock numbers, receipts, expenses and net income for the four farms of typical size before and after reorganization are shown in Tables 18 to 21. Income for 1952 was determined from the crop and livestock programs found on typical farms of different sizes using the

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[7]Four sizes X four amounts of capital available X four land use situations X two employment opportunities X two market situations = 256.

projected price estimates for 1957-66. For greater comparability, each 1952 typical farm operator was credited with an off-farm income of $3,300.

Thus, by using the same prices for products sold and purchased, it is possible to compare net income before reorganization with incomes from the desirable combinations obtained by linear programming.

60-Acre Farms.—The organization of a typical 60-acre farm that will maximize returns when very limited capital ($1,000 additional) is available, is one having one sow and 38 hens, converting 10 acres of pasture to cropland, and with the operator having a 40-hour week job in industry. Some corn would be sold.

If $3,000 of additional capital were available ($2,000 more than above), the plan would be much the same except that 350 hens would be kept. In both of these instances, as seen in Table 18, some hay could be sold. With more chickens, 70 bushels of corn would have to be purchased.

As the available additional capital is increased to $8,000 on the small farm, the best organization is 7 dairy cows producing milk for a grade A market and 320 hens. This plan includes a 40-hour week job off the farm. This number of livestock would require that an extra 19 tons of hay and 85 bushels of corn be purchased in addition to converting 10 acres of pasture to cropland and improving 7½ acres of permanent pasture. Under this plan, all available labor (during peak months) and capital are used. With smaller amounts of capital, only a part of the labor was required.

If capital is not a limiting factor, the organization that will make the best use of all available labor is one having a 16-cow herd producing milk for a grade A market and with the operator still holding a full-time job off the farm. As with the situation above, the same acreage of pasture-land would be converted to cropland and other pasture-land would be converted to cropland and other pasture-land would be improved. The larger dairy herd would also necessitate the purchase of 77 tons of hay and 230 bushels of corn. Under these circumstances, $13,450 of additional capital would be needed for operating capital and the change-over.

If this much additional capital were available, the better organization of the farm could increase income by $2,100 over the typical farm plan in 1952, if the same price assumptions are made for both plans. This is a labor and management return over and above interest. Only about $750 of capital would be needed for cash operating expenses under the 1952 plan.

120-Acre Farm.—For a typical farm of this size, the best organization with only $1,000 of additional capital is 3 sows and 20 hens, converting 15 acres of pasture to cropland and work full-time off the farm.

If $2,000 more capital were available, the same livestock enterprises would be desirable except that they would be 2 sows and 390 hens. In both these situations, 43 tons of hay could be sold and some corn would need to be purchased.

Only a part of the available labor is needed in these two situations.

If another $5,000 of capital could be used on the medium-sized farm, the best plan would be 9 dairy cows, 1 sow and 205 hens. In addition to converting 15 acres to new cropland, an additional 16 acres should be improved pasture. Only 2 tons of hay would need to be purchased and all of the corn would be consumed. This could be done with labor available after working a 40-hour week off the farm but no surplus labor remains during the periods of peak demand.

TABLE 18.—Livestock Numbers and Cash Receipts: 60-Acre Farm Under Present and Optimum Use of Resources, Southeastern Ohio

Item		1952 farm organization*	Optimum organization with specified amounts of additional capital			
			$1,000	$3,000	$8,000	$13,450
Capital used†	dollars	1,000	1,249	3,256	8,221	13,701
Livestock:						
Dairy cows	number	1	0	0	7	16
Sows	do	0	1	1	0	0
Market hogs	do	2	14	14	0	0
Hens	do	30	32	330	320	0
Receipts:						
Dairy cattle	dollars	80	0	0	2,853	6,520
Hogs	do	72	554	554	0	0
Hens	do	0	208	2,148	2,083	0
Wheat	do	148	203	203	203	203
Corn	do	162	119	0	0	0
Hay	do	0	396	396	0	0
Total	do	462	1,480	3,301	5,139	6,723

*Rates of production were as found on sample farms. In many instances, they were lower than these used in linear programming assumptions. Expected prices for 1957-66 were used here to make 1952 farm receipts comparable to those of the adjusted organization.

†Does not include value of land, buildings and machinery, but does include interest charged on all owned capital.

TABLE 18 continued.—Costs, Family Income and Family Earnings for a 60-Acre Farm, Under Present and Optimum Use of Resources, Southeastern Ohio*

Item	1952 farm organization	Optimum organization with specified amounts of additional capital			
		$1,000	$3,000	$8,000	$13,450
Costs:					
Crops:					
Seed	----	64	64	64	64
Fertilizer and lime	----	119	119	119	119
Machinery	----	297	297	297	297
Interest	----	23	23	23	23
Other costs	----	22	22	22	22
Cost of converting pasture	----	32	32	32	32
Cost of improved permanent pasture	----	0	0	53	53
Livestock:					
Commercial feed	----	186	1,154	1,365	742
Purchased corn	----	0	110	133	361
Purchased hay	----	0	0	459	1,860
Veterinary and medicine	----	24	33	83	168
Taxes and insurance	----	6	21	73	130
Interest	----	19	85	263	439
Other costs	----	73	345	557	609
Fixed costs on land and improvements†	----	420	420	420	420
Total	1,181‡	1,285	2,725	3,963	5,339
Family income	—719	195	576	1,176	1,384
Farm products used in home	150	150	150	150	150
Rental value of house	360	360	360	360	360
Family labor earnings from farm	—209	705	1,086	1,686	1,894
Off-farm income	3,300	3,300	3,300	3,300	3,300
Family earnings from all sources	3,091	4,005	4,386	4,986	5,194

*Family income represents returns to family labor and management rather than returns to operator's labor and management.

†Includes taxes, insurance, and interest on investment on land, buildings and improvements.

‡Costs for 1952 were adjusted to 1957-66 price level. No detailed breakdown of costs is available.

On a typical 120-acre farm where capital is not a limiting factor, the plan that yields the highest income is 15 dairy cows producing grade A milk, 1 sow, converting 15 acres of pasture to cropland, improving 20 acres of pasture, with the operator carrying a full-time job off the farm. To do this, one would have to buy 38 tons of hay and 105 bushels of corn.

All available labor would be needed during peak demand periods. The additional capital needed to carry out this plan would amount to $11,800. Where adequate capital is available this better plan of organization could increase net income by nearly $2,400 over the 1952 typical organization, if the same price level is assumed for both plans. About $3,000 of operating capital would be used for the 1952 plan for the typical 120-acre farm.

180-Acre Farm.—If only $1,000 of additional capital is available for the 180-acre farm, its optimum organization would include one sow and 25 hens. Smaller amounts of livestock could be kept because more capital is used to produce crops on larger acreages, and higher initial expense is required to convert more pasture to cropland. It would be desirable to convert 21 acres of pasture to cropland. Because of the

TABLE 19.—Livestock Numbers and Cash Receipts: 120-Acre Farm, Under Present and Optimum Use of Resources, Southeastern Ohio

Item		1952 farm organization*	Optimum organization with specified amounts of additional capital			
			$1,000	$3,000	$8,000	$11,800
Capital used†	dollars	4,450	2,458	4,451	9,458	13,254
Livestock:						
Dairy cows	number	5	0	0	9	15
Sows	do	1	3	2	1	1
Market hogs	do	7	42	28	14	14
Hens	do	40	20	390	205	0
Receipts:						
Dairy cattle	dollars	1,002	0	0	3,668	6,113
Hogs	do	268	1,661	1,107	554	554
Hens	do	120	130	2,539	1,335	0
Corn	do	135	0	0	0	0
Wheat	do	259	396	396	396	396
Hay	do	0	774	774	0	0
Total	do	1,784	2,961	4,816	5,953	7,063

*Rates of production were as found on sample farms. In many instances, they were lower than used in linear programming assumptions. Expected prices for 1957-66 were used here to make 1952 farm receipts comparable to those of the adjusted organization.

†Does not include value of land, buildings and machinery, but does include interest charged on all owned capital.

TABLE 19 continued.—Costs, Family Income and Family Earnings: 120-Acre Farm, Under Present and Optimum Use of Resources, Southeastern Ohio*

Item	1952 farm organization	Optimum organization with specified amounts of additional capital			
		$1,000	$3,000	$8,000	$11,800
Costs:					
Crops:					
Seed	____	126	126	126	126
Fertilizer and lime	____	233	233	233	233
Machinery	____	658	658	658	658
Interest	____	45	45	45	45
Other costs	____	43	43	43	43
Cost of converting pasture	____	47	47	47	47
Cost of improved permanent pasture	____	0	0	112	140
Livestock:					
Commercial feed	____	310	1,431	1,165	777
Purchased corn	____	64	19	0	165
Purchased hay	____	0	0	48	918
Veterinary and medicine	____	70	58	124	180
Taxes and insurance	____	13	28	87	126
Interest	____	41	110	304	424
Other costs	____	151	442	575	616
Fixed costs on land and improvements†	____	674	674	674	674
Total	1,784‡	2,475	3,914	4,241	5,172
Family income	—478	486	902	1,712	1,891
Farm products used in home	150	150	150	150	150
Rental value of house	360	360	360	360	360
Family labor earnings from farm	32	996	1,412	2,222	2,401
Off-farm	3,300	3,300	3,300	3,300	3,300
Family earnings from all sources	3,332	4,296	4,712	5,522	5,701

*Family income represents returns to family labor and management rather than returns to operator's labor and management.

†Includes taxes, insurance, and interest on investment on land, buildings and improvements.

‡Costs for 1952 were adjusted to 1957-66 price level. No detailed breakdown of costs is available.

small number of livestock, 737 bushels of corn and 65 tons of hay could be sold. Here too, it would be more profitable to have an off-farm job than to try to farm full time.

If $2,000 more capital could be used, livestock would be increased to four sows and 181 hens. Other things would be the same except

that 21 bushels of corn would be purchased instead of selling surplus corn. Capital, rather than labor, is the limiting factor in these two situations.

If another $5,000 of capital were made available, the best plan would include 8 dairy cows, 3 sows, 167 hens, converting 21 acres to cropland, and an off-farm job for the operator. Twenty-one tons of hay could be sold and a small quantity of corn would have to be purchased.

On the typical 180-acre farm, if capital were not a limiting factor, the optimum plan would be 13 dairy cows, 3 sows, converting 21 acres of pasture to cropland, improving 31½ acres of pasture, and an off-farm job for the operator. About 7 tons of hay could be sold. It would be necessary to buy 155 bushels of corn. All of the available labor would be needed during peak periods. The additional capital needed under this plan would be $11,350.

TABLE 20.—Livestock Numbers and Cash Receipts: 180-Acre Farm, Under Present and Optimum Use of Resources, Southeastern Ohio

Item		1952 farm organization*	Optimum organization with specified amounts of additional capital			
			$1,000	$3,000	$8,000	$11,350
Capital used†	dollars	6,975	2,478	4,474	9,459	12,815
Livestock:						
Dairy cows	number	0	0	0	8	13
Sows	do	1	1	4	3	3
Market hogs	do	7	14	56	42	42
Hens	do	100	25	181	167	0
Beef cows	do	12	0	0	0	0
Fat cattle	do	10	0	0	0	0
Receipts:						
Dairy cattle	dollars	0	0	0	3,260	5,298
Hogs	do	268	554	2,214	1,661	1,661
Hens	do	505	163	1,178	1,087	0
Beef cattle	do	2,016	0	0	0	0
Wheat	do	407	599	599	599	599
Corn	do	0	995	0	0	0
Hay	do	0	1,170	1,152	378	126
Total	do	3,196	3,481	5,143	6,985	7,684

*Rates of production were as found on sample farms. In many instances, they were lower than those used in linear programming assumptions. Expected prices for 1957-66 were used here to make 1952 farm receipts comparable to those of the adjusted organization.

†Does not include value of land, buildings, and machinery, but does include interest charged on all owned capital.

TABLE 20 continued.—Costs, Family Income and Family Earnings: 180-Acre Farm, Under Present and Optimum Use of Resources, Southeastern Ohio*

Item	1952 farm organization	Optimum organization with specified amounts of additional capital			
		$1,000	$3,000	$8,000	$11,350
Costs:					
Crops:					
Seed	____	190	190	190	190
Fertilizer and lime	____	353	353	353	353
Machinery	____	1,372	1,372	1,372	1,372
Interest	____	68	68	68	68
Other costs	____	65	65	65	65
Cost of converting pasture	____	66	66	66	66
Cost of improved permanent pasture	____	0	0	0	221
Livestock:					
Commercial feed	____	163	915	1,159	848
Purchased corn	____	0	33	107	243
Purchased hay	____	0	0	0	0
Veterinary and medicine	____	24	97	158	205
Taxes and insurance	____	5	26	86	118
Interest	____	18	88	293	393
Other costs	____	66	341	588	628
Fixed costs on land and improvements†	____	1,055	1,055	1,055	1,055
Total	3,196‡	3,445	4,669	5,560	5,825
Family income	—399	36	474	1,425	1,859
Farm products used in home	150	150	150	150	150
Rental value of house	360	360	360	360	360
Family labor earnings from farm	111	546	984	1,935	2,369
Off-farm income	3,300	3,300	3,300	3,300	3,300
Family earnings from all sources	3,411	3,846	4,284	5,235	5,669

*Family income represents returns to family labor and management rather than returns to operator's labor and management.

†Includes taxes, insurance, and interest on investment on land, buildings, and improvements.

‡Costs for 1952 were adjusted to 1957-66 price level. No detailed breakdown of costs is available.

The net income under this plan could be about $2,250 higher than under the 1952 typical organization if both plans operated under the same price situation. Under the before—or 1952 plan—about $5,500 of operating capital would be needed.

220-Acre or Large Farm.—For this typical large farm if only $1,000 of additional capital were used, 2 sows should be kept, 23 acres of pasture should be converted to cropland, and the operator should work at off-farm jobs. All of the hay produced and 735 bushels of corn should be sold.

If $2,000 more capital could be used, livestock should be increased to 5 sows and 150 hens. Most of the hay could be sold and 20 bushels of corn would be purchased. Capital is the limiting factor in these 2 situations. Surplus labor is still available.

When $5,000 more capital is made available, the optimum plan includes 8 dairy cows, 4 sows, 133 hens, converting 23 acres of pasture to cropland, and off-farm job for the operator. All available capital and labor are utilized. About 36 tons of hay can be sold. About 65 bushels of corn must be purchased.

TABLE 21.—Livestock Numbers and Cash Receipts: 220-Acre Farm, Under Present and Optimum Use of Resources, Southeastern Ohio

Item		1952 farm organization	Optimum organization with specified amounts of additional capital			
			$1,000	$3,000	$8,000	$10,425
Capital used†	dollars	8,850	2,995	4,951	9,916	12,371
Livestock:						
Dairy cows	number	12	0	0	8	12
Sows	do	1	2	5	4	3
Market hogs	do	14	28	70	56	42
Hens	do	150	0	150	133	0
Receipts:						
Dairy cows	dollars	3,048	0	0	3,260	4,890
Hogs	do	554	1,107	2,768	2,214	1,661
Hens	do	976	0	976	866	0
Wheat	do	518	729	729	729	729
Corn	do	155	992	0	0	121
Hay	do	0	1,422	1,404	648	504
Total	do	5,251	4,250	5,877	7,717	7,905

*Rates of production were as found on sample farms. In many instances, they were lower than used in linear programming assumptions. Expected prices for 1957-66 were used here to make 1952 farm receipts comparable to those of the adjusted organization.

†Does not include value of land, buildings and machinery, but does include interest charged on all owned capital.

TABLE 21 continued.—Costs, Family Income and Family Earnings: 220-Acre Farm, Under Present and Optimum Use of Resources, Southeastern Ohio*

Item	1952 farm organization	Optimum organization with specified amounts of additional capital			
		$1,000	$3,000	$8,000	$10,425
Costs:					
Crops:					
Seed	____	231	231	231	231
Fertilizer and lime	____	429	429	429	429
Machinery	____	1,628	1,628	1,628	1,628
Interest	____	83	83	83	83
Other costs	____	79	79	79	79
Cost of converting pasture	____	72	72	72	72
Cost of improved permanent pasture	____	0	0	0	246
Livestock:					
Commercial feed	____	163	896	1,130	802
Purchased corn	____	0	31	102	0
Purchased hay	____	0	0	0	0
Veterinary and medicine	____	46	119	180	195
Taxes and insurance	____	8	28	88	110
Interest	____	24	94	297	366
Other costs	____	88	357	602	586
Fixed costs on land and improvements†	____	1,348	1,348	1,348	1,348
Total	5,251‡	4,199	5,395	6,269	6,175
Family income	—326	51	482	1,448	1,730
Farm products used in home	150	150	150	150	150
Rental value of house	360	360	360	360	360
Family labor earnings from farm	184	561	992	1,958	2,240
Off-farm income	3,300	3,300	3,300	3,300	3,300
Family earnings from all sources	3,484	3,861	4,292	5,258	5,540

*Family income represents returns to family labor and management rather than returns to operator's labor and management.

†Includes taxes, insurance, and interest on investment on land, buildings, and improvements.

‡Costs for 1952 were adjusted to 1957-66 price level. No detailed breakdown of costs is available.

When additional capital can be used, the optimum organization is 12 dairy cows, 3 sows, converting 23 acres of pasture to cropland, improving about 35 acres of pasture, and an off-farm job. Enough feed would be produced so that 28 tons of hay and 90 bushels of corn would be available for sale.

Capital needed for operating expenses and change-overs for this plan would amount to $10,400. At peak demand periods, all available labor would be needed. Net income would be about $2,050 higher under the plan just discussed than under the 1952 typical plan, assuming the same prices for both. About $6,900 of operating capital would be used under the 1952 plan.

The optimum plans of organization listed above were arrived at by linear programming. These plans make the best use of labor, capital and feed to yield the highest net income for each of the typical farms studied. Higher farm income under these suggested plans comes largely from raising more livestock of higher quality. These changes usually require more labor and more capital. No other combination of these enterprises would yield more income if the same yields, prices, returns and costs were used.

For these four typical farm situations in southeastern Ohio, a higher net income is possible for any of the sizes and at any level of available capital, if as much farming as available labor will permit is carried on along with an off-farm job.

Some farmers may not be able to work at off-farm jobs because of age or lack of job opportunities. If enough capital is available (more than $3,000), they can expand livestock activities but even so, the total net income will be lower than it would be from part-time farming along with a job off the farm.

In Table 18 through 21, the net farm income shown is higher for each of the optimum plans, regardless of how much capital is available, than for the typical organization followed in 1952. Some of this difference is due to more and better quality livestock and to assumed better management. With the same level of operating capital available as in the 1952 typical organization, the optimum plans produce from $800 to $1,500 more net farm income.

Also, for each available capital level, the 120-acre typical farm yields a higher net farm income than any of the three other sizes of farms. As size of farm increases from 60 to 120 acres, an increase in net income is to be expected. The reason that net income does not increase as size increases to 180 and 220 acres is explained by the interplay in increased acreages of crops and the increased demand for capital and labor that results.

When capital is limited, the increased acreages in crops and the resulting need for capital limit the amount available for investment in productive livestock. As regular crop acreage increases from 28 to 44

acres in the typical 180-acre farm as compared with the typical 120-acre farm, this additional 16 acres requires $336 more operating capital. The additional 6 acres of pasture that can be converted to cropland requires an initial capital outlay of $306. Thus, we see that $642 less operating capital is available for investment in productive livestock. It will be noted that the optimum plan for the 180-acre farm with $1,000 additional capital had only 1 sow, while the 120-acre farm with the same capital had 3 sows. This reduction grew out of other demands for the scarce capital.

A similar competitive situation for capital arises as the size of farm increases to 220 acres. There are 12 more acres of regular cropland and more land is available for conversion to cropland and for improved pasture.

As capital supplies were increased, the other limit of scarce labor supply has its influence in much the same way as did capital in the above example. More crop acres on the larger farms require more crop labor and leave less labor available for livestock care. Thus, livestock numbers are reduced, and as a result, total net farm income is reduced.

An additional difference is that the fixed overhead for the larger farms in the form of taxes, insurance, depreciation and interest is greater for the 180- to 220-acre farms than for the 120-acre farm.

The lower incomes on the 180- and 220-acre farms, then, did not result from differences in yields or resource quality, but from the fact that the fixed charges on the larger units increased considerably more than the returns as labor and capital resources became limited.

This study emphasizes the problem of overinvestment in land for part-time farmers. In the present case an operator with a 40-hour per week off-farm job would be financially ahead to either sell or rent out the acreage in excess of 120.